

NOTES ON NEW GUINEAN SPECIES OF TRIPTEROIDES, SUBGENUS RACHISOURA (DIPTERA, CULICIDAE), WITH DESCRIPTIONS OF TWO NEW SPECIES

BY

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INTRODUCTION

The genus *Tripteroides* occurs in the Oriental and the Australasian regions. After EDWARDS (1932) the genus is divided into 4 subgenera: *Maorigoeldia* (monotypic and endemic in New Zealand); *Rachisoura* (New Guinea and adjacent islands to the east, including the Solomons and N. Australia, with an optimum of at least 20 known species in New Guinea); *Tripteroides* (Oriental and Australasian; an optimum of at least 30 species in the Philippines) and *Mimeteomyia* (Australasian). BELKIN (1950) gives a detailed account of the geographical distribution of the subgenera. Revision of subgeneric characters seems necessary, however, in the light of recent discoveries (BELKIN, 1950; BAISAS & UBALDO-PAGAYON, 1952).

The subgenus *Rachisoura*, as understood in the present paper, is a natural, rather well defined taxon; the adults are unornamented and characterized by a pattern of broad wing scales at least on veins 1 and 2; in the larvae there are highly modified maxillae whereas thoracic spines are absent. The distribution of the subgenus is rather limited and within this area many species seem to have a limited distribution of their own: known species from New Guinea at least 20 (continued collecting certainly will add to this number), from the Solomons 3; from tropical Australia 2. All Solomon species are endemic and so are most of New Guinea. Only two species occur in both New Guinea and Australia (*T. filipes* and *T. brevirhynchus*).

BAISAS & UBALDO-PAGAYON (l.c.) described a Philippine species, *T. mabini*, which they included because of the larval maxillae in the subgenus *Rachisoura*; this species, however, is extremely aberrant from all other *Rachisoura* species. As modified larval maxillae also occur in still another subgenus (*Mimeteomyia*) (BELKIN, 1950) and also because of its geographic relations it is much more acceptable to understand *mabini* as an offshoot of the subgenus *Tripteroides*, resembling a *Rachisoura* by a convergent development of the modified larval maxillae, rather than widening the definition of the subgenus *Rachisoura* to a meaningless conception.

Larvae of many *Rachisoura* species (in fact many species of the other subgenera as well) live in a quite peculiar habitat, viz, in the liquid inside the pitchers of *Nepenthes*, an environment which requires special adaptations to be

invaded successfully. Other species are found in rainfilled internodes of cut bamboos or in leafaxils of keladi plants (*Colocasia* and *Alocasia* spp., Araceae). The preference for one certain type of breeding place seems to be quite rigid. Only one species (*T. bisquamata*) was found in pitchers, bamboos and leafaxils. Within the subgenus *Rachisoura* a diversity in development of the apical teeth on the larval maxillae is noticeable. This diversity is in fact so striking that one wonders about its function and how such a diversity developed in closely related species occupying the same ecological niche, frequently in the same locality. At Ifar (foothills of the Cyclop Mountains) *T. bisquamata*, *kingi* and *filipes* were collected from *Nepenthes* pitchers on the grassy slopes. At Hollandia and Mamda (Nimboran district) *T. vanleeuweni*, *T. bisquamata*, and *T. longipalpata* were found together with *T. (Mimeteomyia) argenteiventris* and *T. (Tripteroides) quasiornata* in cut bamboos. At Homejo and Enarotali (Wissel Lakes district) *T. cuttsi* spec. nov., *T. flabelligera*, and *T. (Mimeteomyia) microlepis* lived together in *Nepenthes* pitchers in mossy forest. Perhaps these closely related species are able to maintain themselves in the same habitat niche because of this morphological, hence functional, difference resulting in a different exploitation of the environment. The toothed maxillae have a function in feeding as clasping organ; besides they have a function in aggressive behaviour between larvae. While feeding the maxillae are kept in an obliquely downwards position, the teeth pointing medio-ventrally. The fanning movements of the rostral mouthbrushes cause a stream of particles directed backwards. Large particles in this stream and more often large particles searched for actively are seized by the maxillar claspers and probably tested or grounded by the saw-edged mandibles situated on a deeper level partly in front of the maxillae. As far as could be observed the maxillae themselves have no function in grounding food particles, they serve exclusively as clasping organs, contrary to analogous structures found in real predatory larvae, as are in this territory *Toxorhynchites* and *Culex (Lutzia)* species. A large food particle (e.g., part of the body of a drowned insect) may be clasped and lifted to the surface by the larva ascending for siphonal oxygen uptake, while eating is continued all the time. The diversity in shape in the *Rachisoura* maxillae may be related to the wide variety in food, as e.g., the organisms drowned in the fluid inside a pitcher or bamboo; a special clasper may fit best to a certain type of food, although no experimental evidence can be produced for this view. Pitchers at Ifar contained above all several ant species (some pitchers even exclusively), in addition were spiders, many moths, cockroaches, big-sized centipeds, many flies (viz, Tabanidae and Tachinidae), also bugs, Vespidae (sometimes the big *Vespa tropica*), Apidae, grasshoppers and locusts, sometimes a beetle. Drowned, adult *Tripteroides* specimens were never found.

Rachisoura larvae may fight one another to death; the victim's body being consumed afterwards. This cannibalism seems to have a regulating function as it compensates overcrowding and keeps the number of larvae present at one time in relation to the amount of available food (Cf. chapter on biology below). It always is the smaller individual underlying a bigger one. Sometimes a fight ends in a draw; at one time I observed a fight between two *T. bisquamata* larvae lasting two hours without its coming to a decision. Larva A had seized B with its maxillae, one between its head capsule and thorax and one between its mouth



Fig. 1. Pitchers of *Nepenthes mirabilis* in situ. Ifar, 1000 feet, foothills of Cyclop Mountains

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parts, the position of the larvae being perpendicular; all the time maxillae, rostral mouth brushes and antennae moved fiercely. B displayed an ambivalent behaviour; trying to get rid of A by making fierce swimming movements alternated by trying to get hold of A by making snapping movements with its maxillae. One peculiar escape reaction of B has to be noted. By and by B bent its abdomen and placed the forket between its siphon and anal segment to the anterior margin of A's head capsule. It tried to get rid of A by pushing and at one moment succeeded in doing so indeed. From this short description it may be clear that an even rather complicated pattern of aggression and escape behaviour exists in the larvae. About the factors causing and releasing this behaviour pattern nothing is known; maybe a certain degree of starvation is one of the indirect causal factors (Cf. chapter on biology below).

TAXONOMY

The following species are discussed or described in this paper.

T. filipes (Walker), Ifar (02.33 S 140.32 E), 1000 ft., *Nepenthes* on grassy slopes of Cyclop Mountains foothills.

T. fuscipleura Lee, Homejo (0.3.42S 136.41E), Kemabu valley, 5400 ft; Djik (02.40S 140.11E), Nimboran district, *Colocasia* axils.

T. flabelligera Bonne-Wepster, Enarotali (03.56S 135.21E), 6000 ft; Homejo, 6000 ft, *Nepenthes* in mossy forest.

T. longipalpata Lee, Hollandia (02.36S 140.40E); Mamda (02.36S 140.25E), cut bamboos.

T. bisquamata Lee, Ifar, 1000 ft, *Nepenthes* pitchers; Ifar, 1500 ft, *Colocasia* axils; Hollandia, Mamda, cut bamboos.

T. vanleeuweni (Edwards), Ifar 600 ft., cut bamboos; Mamda, cut bamboos.

T. kingi Lee, Ifar 1000 ft., *Nepenthes*.

T. cuttsi spec. nov., Enarotali 6000 ft., Homejo 6000 ft., climbing *Nepenthes* in mossy forest.

T. adentata spec. nov., Ifar 1500 ft., climbing *Nepenthes* in virgin rain forest.

Type material is deposited, if not stated otherwise, in the Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands.

Tripteroides filipes (Walker) ·

WALKER, F., 1861, Proc. Linn. Soc. Lond., vol. 5, p. 299.

LEE, D. J., 1946, Proc. Linn. Soc. N.S.W., vol. 70, p. 242.

Type locality: Manokwari (= Dorey), Vogelkop Peninsula.

The specimens before me were all bred from larvae collected from *Nepenthes* pitchers on dry grassy slopes on the foothills of the Cyclop Mountains near Ifar, 1000 ft., VI—X 1958. They match the description as given by LEE (1946) in most characters; there are some differences, however, in the lobes of the male ninth tergite. In one male these lobes are rather blunt, well-separated and with 14—16 setae arranged in a more or less double row, on the distal margin (fig. 1); in a male of the same series only eight setae are present as illustrated by LEE

(1946, fig. 24). Setae are rather stout but relatively short, all of the same size, gradually tapered in apical part, extreme apex very narrow, thread-like. In the females the hind tibiae are longer than in LEE's specimens, being 88% the length of mid tibia, instead of 75—78%.

Tripteroides fuscipleura Lee

LEE, D. J., 1946, Proc. Linn. Soc. N.S.W., vol. 70, p. 246.

Type locality: Doromena (Pacific side of Cyclop Mountains, West of Hollandia).

A female specimen collected as a pupa from a *Colocasia* axil in a narrow shaded streambed at Homejo, Kemabu valley, at 4500 ft., VIII.1958, is almost certainly this species. Associated were *Harpagomyia* spec. nov. and *Culex* (*Acalyntrum*) spec. nov. near *pallidiceps*.

A small series of this species, comprising 5 males, 3 females and 5 larval skins, were collected from *Colocasia* axils at Djik (Nimboran district), XII.1958. Species associated was *Harpagomyia leei*.

The adult specimens agree almost entirely with LEE's description. There are 3—5 spiracular bristles and 5—6 setae on the lobes of the ninth tergites in the males. These setae are curved sideways in the apical part; the lateral setae are distinctly stouter than the more central ones.

In the larvae the pecten spines are arranged along the length axis of the siphon, they are absent only in the apical quarter. There are 15—16 ventral siphonal hair tufts and 9 dorsal tufts, the ventrals arranged from base towards apex, the dorsals absent in apical quarter. The saddle of the anal segment is only weakly chitinized, the saddle hair is very inconspicuous in comparison with ventral beard and ventral- and dorsal subcaudals. The ventral beards are very well developed and distinctly frayed. The ventral subcaudal is single or bifid. The comb teeth on the 8th abdominal segment are different in size, the lateral ones being smaller than the medial ones.

Tripteroides flabelligera Bonne-Wepster

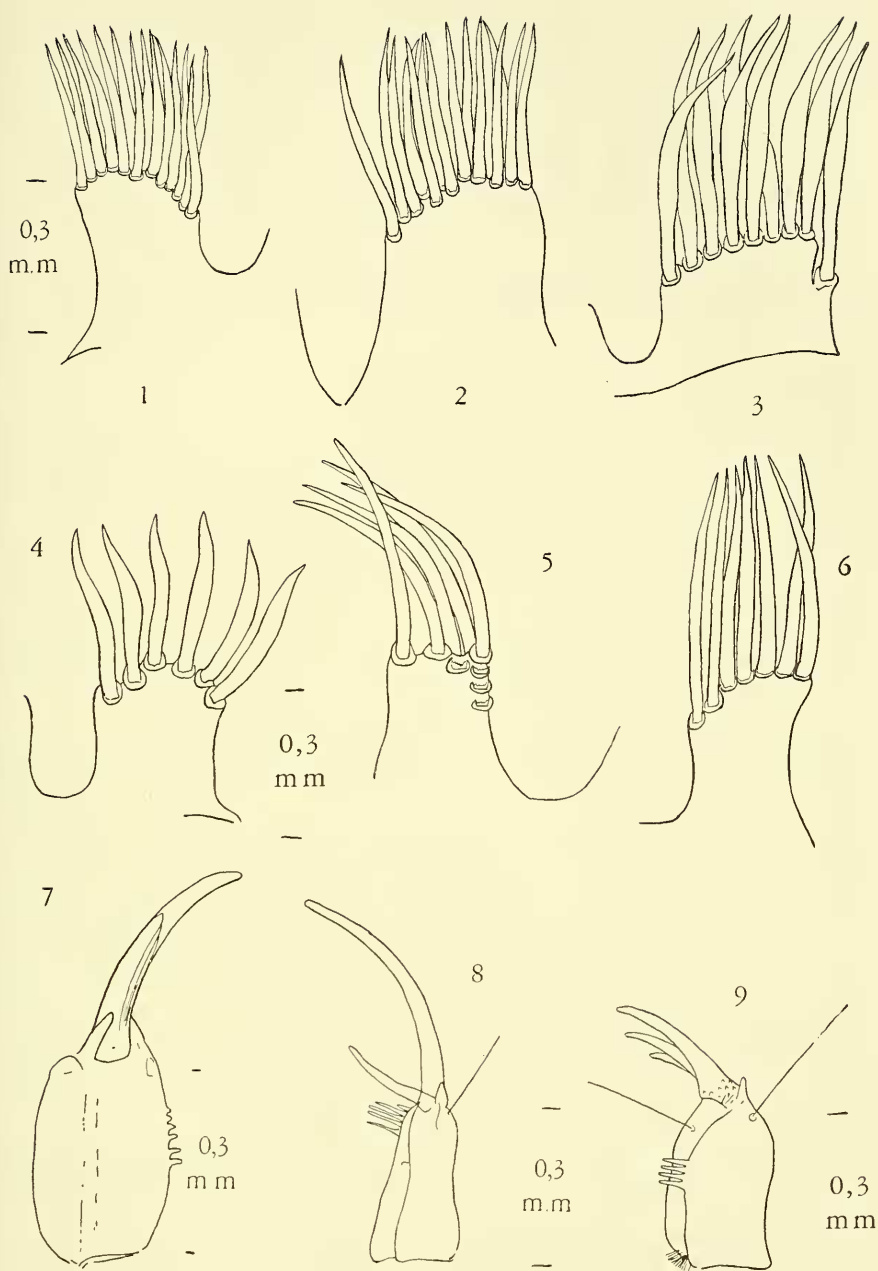
BONNE-WEPSTER, J., 1948, Treubia, vol. 19, p. 308.

Type locality: Mist Camp, Baliem valley, C. Highlands, 6.300 ft.

This species was described by BONNE-WEPSTER from one female, not in the best of conditions. Male and larva remained undescribed.

The allotype specimen is male Hj 12-a with connected larval skin. The source of the paratype series is Homejo (Kemabu valley) collected from climbing *Nepenthes* in mossy forest at about 6000 ft., VIII.1958. Other specimens were collected in similar localities near Enarotali (Wissel Lakes) at the same altitude. Among females biting in daytime in the forest there were no females of this species. A rather big and conspicuous species of *Tripteroides*.

The larvae were found associated with *T. cuttsi* spec. nov. and *T. (Mimeteomyia) microlepis*. (The still undescribed larvae of the latter species will be dealt with elsewhere).



Figs. 1—6. Lobe of ninth tergite of *Tripteroides* species. 1. *T. filipes*, 2. *T. flabelligera*. 3. *T. vanleenweni*, 4. *T. kingi*, 5. *T. cutsi*, 6. *T. adentata*. Figs. 7—9. Larval maxilla of *Tripteroides* species, 7. *T. flabelligera*, 8. *T. longipalpata*, 9. *T. bisquamata*

Male. Head clothed with flat scales which are slightly reflecting, on the nape a patch of lighter scales, dark erect scales caudally, a narrow rim of light scales borders the eyes; flat golden scales laterally down the head. Palpi dark scaled, slender, 0.75 the length of the proboscis; proboscis dark scaled, distinctly longer than forefemur. Clypeus black with narrow white scales present on dorsal surface. Mesonotum clothed with moderate large, curved, bronzy scales; integument of pleura dark brown to black, especially in the caudal part; pleural scales cream coloured, scales in upper part of posterior pronotum golden or golden brown. One posterior pronotal bristle; 3—5 black spiraculars and 3—5 pairs of golden prescutellars. Postnotum dark brown, in the medio-distal part a tuft of tiny hairs and some elongated white scales present; this pattern is partly present in some and entirely lacking in other specimens; probably it is very easily rubbed off since all specimens were collected straight after hatching.

Legs dark scaled, a narrow band of golden reflecting scales present on the ventral side of the femora, most conspicuous in the fore femora; hind tibia 0.8 the length of the mid ones. Wing scales dark brown, costal scales blackish, all scales broad; upper fork cell twice the length of its stem, the fork cell bases level. Wing length 5 mm. Dorsum of abdomen dark scaled, patches of golden scales at the apico-lateral margins of the sternites; venter golden scaled. Lobes of 9th. tergites well separated, broad, 14—16 setae present on apical part (fig. 2).

All setae of about the same size, narrow in apical part, pointed at extreme apex.

Female mainly as in male. Palpi slightly over 0.2 the length of the proboscis, extending from the clypeus for about 4 times the length of the latter.

Larva. Clypeal spines long and slender, Antennal shaft hair long and single, far beyond middle. Head hair A 2—4 branched; B 4-branched, distinctly more rostrally than A; C single, fairly long, behind the level of A; d 4—5 branched. Maxilla with a long apical tooth which is slightly longer than the body of the maxilla and 4 shorter, assessor teeth. (Fig. 7). Stellate tufts on thorax and abdomen with 4—10 branches. Lateral comb comprises 7—10 teeth with frayed basal part. Siphonal index 2 or slightly more, siphon distinctly tapered towards apex; pecten with 5—7 spines from about halfway to apex, a strong spine being present at apex; apico-dorsal spines long and slender. Ventral hairs 11—12, 3—4-branched, frayed; dorsal hairs 9, 3—5-branched, frayed; ventral siphonal valve hair long, 3-branched. Saddle with sharp spines at distal margin; saddle hair single. Dorsal subcaudal with 6 branches; ventral subcaudal single; ventral tuft with 7 branches. All these hairs are finely frayed (fig. 14).

Mrs. BONNE-WEPSTER compared specimens of this species with the holotype of *Tripteroides flabelligera*, preserved at Amsterdam. She noted following particulars: in the holotype the pleural integument is much lighter, it may however be discoloured; the proboscis is only slightly longer than the fore femur and there are no scales present on clypeus. There are 4 spiraculars and 1 posterior pronotal, the hind tibia is distinctly shorter than the mid tibia.

Tripteroides longipalpata Lee

LEE, D. J. 1946. Proc. Linn. Soc. N.S.W., vol. 70, p. 250.

Type locality: Hollandia.

Larvae of this species were collected from cut bamboos: two specimens at Mamda (Nimboran district) from bamboos in a rest of a rain forest, VI.1958, one specimen from bamboos at the road side at Hollandia, XI.1958. From the latter a female was bred, from the former one male specimen. The male matches entirely the description by LEE, the female is still undescribed, in the larval characters appear to be some deviations from the original description.

This species presumably is rather rare: intensive search for additional specimens in bamboos, leaf axils and pitchers never yielded more than those mentioned above.

T. longipalpata was found associated with larvae of *Tripteroides* (R.) *bisquamata*; *T.* (R.) *vanleenweni*, *T.* (M.) *argenteiventris*, and *Aedes* (*Leptosomatomyia*) *lateralis*.

Female. Head dorsally with dark, flat scales, light reflecting scales on the nape, white scales laterally down the head, a narrow rim of white scales bordering the eyes. Palpi and proboscis dark brown scaled, the former with few light scales in the basal part; proboscis relatively long, four times the length of the palpi, equal in length to the fore femur. Clypeus brown. Scutum clothed with dark brown scales. Pleural integument light brown, largely covered with pale scales; posterior pronota light scaled in basal part, bronze coloured scales in the upper part present. One distinct posterior pronotal bristle; three spiraculars; prescutellars absent. Postnotum brown, a small patch comprising at least 10 fine white hairs in medio-distal part. Legs dark scaled, light scales present ventrally on femora from base to apex; hind tibia 0.9 the length of midtibia. Wing scales all broad, rather blackish with a peacock-blue gloss in some lights; upper fork cell 2.5 times the length of its stem vein. Fork cell bases level. Dorsum of abdomen dark scaled, venter light scaled, large triangles of white scaling present laterally on tergites.

The female allotype of this species is deposited in the collection of the Koninklijk Instituut voor de Tropen, Amsterdam.

Some additional larval characters as noted in the Mamda (M) and Hollandia (H) specimens: The large apical tooth on the maxilla is not quite twice the length of the maxilla body, besides it is distinctly more curved than illustrated by LEE (fig. 47, p. 254) (fig. 8). Lateral comb comprises 3 multidentate spines (H). Siphonal index 1.8 (M) — 1.5 (H); 12—13 (H) pecten spines, spines are absent in basal $1/4$ (M) — $1/5$ (H) part. Saddle hair relatively short, plumose, single (H) or bifid (M). Ventral subcaudal single, dorsal subcaudal with 4 plumose branches; ventral tuft 4—6 branched. As in LEE's specimens the ventral surface of the anal segment is densely clothed with short spinules.

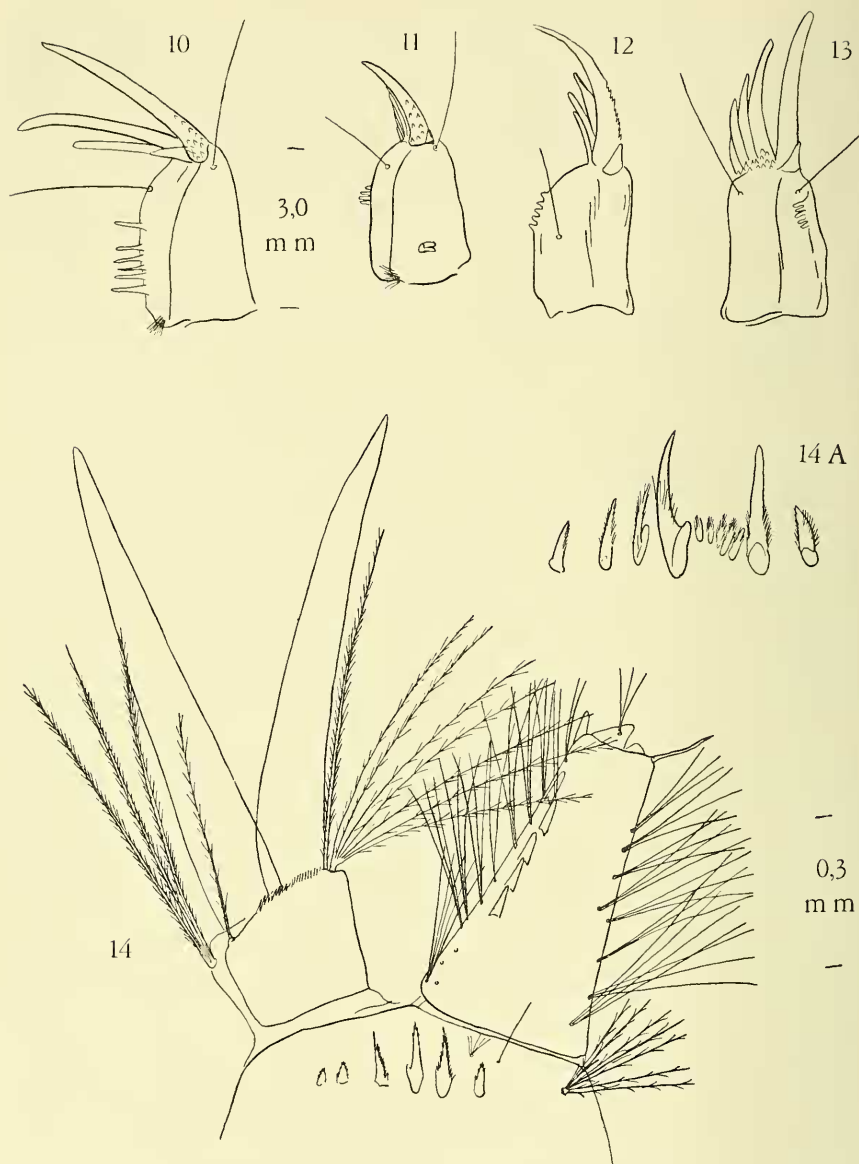
Tripteroides bisquamata Lee

LEE, D. J., 1946. Proc. Linn. Soc. N.S.W., vol. 70, p. 252.

Type locality: Hollandia.

Specimens of this species were collected the year round at Ifar, 1000 ft, from *Nepenthes* pitchers on dry grassy slopes of the foothills of the Cyclop Mountains.

Associated species: *T.* (R.) *filipes* and *T.* (R.) *kingi*. From *Colocasia* axils in the streambed of a mountain current in the Cyclops at 1500 ft.; associated species:



Figs. 10—13. Larval maxilla of *Tripteroides* species. 10. *T. vanleeuweni*, 11. *T. kingi*, 12. *T. cuttsi*, 13. *T. adentata*. Fig. 14. Larval terminal segments of *T. flabelligera*. Fig. 14A. Aberrant lateral comb of specimen HL-PLa

Harpagomyia leei. Hollandia, from cut bamboos at the roadside; associated species: *T. (R.) vanleeuweni*, *T. (M.) argenteiventris*, *T. (T.) bimaculipes*, *Aedes (F.) notoscriptus*, *Ae. (S.) scutellaris*, *Ae. (L.) lateralis*, *Uranotaenia nigerrima*. Mamda (Nimboran district) from cut bamboos in a rest of rain forest; associated species: *T. (R.) vanleeuweni* and *Aedes (L.) lateralis*. Female specimens almost certainly belonging to this species were seen from Teminaboean

(Vogelkop Peninsula). At Ifar, *T. bisquamata* is a common species, biting preferably in the afternoon hours and occasionally entering houses. In the pitchers in open grass land it is the dominant species by far, almost every pitcher searched contained one or more specimens. Biological observations on the Ifar populations of this species are presented in Section III. Larval maxilla is illustrated in fig. 9.

A female specimen from cut bamboo, Mamda, is aberrant in having 8 spiraculars. There are, however, no prescutellars; the palpi are short (0.2 the length of the proboscis) and the hind tarsal claws are clearly double. Though there is not yet strict evidence, there may exist distinct races in *bisquamata*, mainly different in preference for the type of breeding place.

Tripteroides vanleeuweni (Edwards)

EDWARDS, F. W., 1927, Nova Guinea (Zoologie), vol. 15, p. 335.

Type locality: Rouffaer river, 1200 ft.

This species is fairly badly defined as EDWARDS described it from four female specimens only (collected by DOCTERS VAN LEEUWEN near the Rouffaer river, Upper Mamberamo basin). *T. vanleeuweni* was not represented in the extensive *Tripteroides* collections from the Hollandia district, made by the U.S. Army 19th Medical General Laboratory during the Pacific war, which is quite remarkable as the species turns out to be rather common. Recently larvae were collected from cut bamboos at the border of rain forest at Ifar, 600 feet, at Hollandia from bamboos at the roadside at sea level and at Mamda (Nimboran district) from bamboos in a rest of rain forest. Associated species were *Tripteroides* (R.) *longipalpata*, *T.* (R.) *bisquamata*, *T.* (*Mimeteomyia*) *argenteiventris*, *T.* (T.) *bimaculipes*, *Aedes* (Finlaya) *notoscriptus*, *Ae.* (F.) *gani*, *Ae.* (*Leptosomatomyia*) *lateralis*, *Ae.* (*Stegomyia*) *scutellaris*, *Culex* (*Neoculex*) spec., *Toxorhynchites splendens* and *Uranotaenia nigerrima*. The female specimens bred from the larvae do not match EDWARDS' description exactly (male and larva are still undescribed), but the variability of the species will be much greater than can be told from four specimens. An extension of EDWARDS' description is given below.

Female. Proboscis and palpi dark scaled, the latter 0.20—0.25 the length of the former. Proboscis about 0.8 the length of the fore femur. Thoracal integument on pleura medium brown, mesonotal scales bronzy-brown with some bluish gloss; scales in upper part of posterior pronotum brownish, white in the lower part. At least 5 spiracular bristles and 1—2 pairs of prescutellar bristles present. Upper fork cell of wing over 2 times the length of its stem vein; the fork cell bases level or upper one slightly nearer to the wingbase. Hind tibia up to 0.85 the length of the mid one. Borderline between dark and light scaling on the abdomen distinctly serrate on distal segments.

Male. Head covered with dark flat scales with a bluish gloss in some lights; a narrow rim of flat white scales, interrupted in the median, borders the eyes; narrow dark erect scales caudally on the head; flat white scales laterally down the sides. Palpi and proboscis dark scaled, the former 0.65—0.7 the length of the latter; proboscis as long as fore femur. Clypeus blackish, bare. Antennal torus

black with distinct, white dusting and few tiny white hairs. Integument of thorax dark brown on the pleura, blackish on the dorsum. Mesonotal scales rather narrow, spindle-shaped, bronzy with some bluish gloss; some light, hairlike scales at the anterior border; pleura largely covered with purely white scales, posterior pronotum with bronze coloured scales in the upper part. No posterior pronotal bristle and no upper sternopleurals present; 6 spiraculars and 2 pairs of, rather weak, prescutellar bristles present. Upper fork cell of the wings about 2.5 times the length of its stem vein; base of upper fork cell somewhat nearer to the wing base than the lower ones. Coxa white-scaled, with long golden hairs; legs largely scaled, with a bluish or violet reflection in some lights, light scales present on the ventral surface of femora, most conspicuous in the mid-pair where light scales extend from base to apex; tarsal claws single, black, rather small in the hind legs, those on fore and midlegs large and curved; hind tibia 0.8 the length of the midtibia. Dorsum of abdomen dark scaled, venter white scaled, white scales present on lateral part of tergites, the border line between light and dark scaling is almost straight. Lobes of ninth tergites of the terminalia broad, well separated however not deeply emarginate, 7—9 setae on the distal margin as illustrated in fig. 3. All setae of about the same size, in the apical half distinctly broadened to a leaf-like structure, more apically rather abruptly tapered and ending in a long and narrow apex.

Larva. Clypeal spines long and slender. Antennal shaft hair small, single, implanted at $1/3$ — $1/4$ away from apex. Head hair A single, fairly long; B trifid; C trifid behind the level of A; d relatively long, bifid. Maxilla with main tooth distinctly longer than the maxilla body, 2—3 accessory teeth, decreasing in size, the second largest one only some what smaller than the main tooth (fig. 10). Lateral comb on 8th abdominal segment with 6—7 teeth, two or three in the middle distinctly larger than the lateral ones. Siphonal index about 3, siphon tapered towards apex; there are 4—6 pairs of pecten spines arranged from apex towards $2/3$ basally, spines absent in basal $1/3$ and apical $1/4$ part, one pair of stout spines present at extreme apex; 12 three-branched, frayed, dorsal hairs, which are absent in extreme basal and apical parts of siphon; 17 mostly three-branched ventral hairs, the most basal pair up to 8-branched. Saddle smooth, small spines present at the distal margin, saddle hair relatively short, frayed and simple. Dorsal subcaudal up to 9-branched, frayed; ventral subcaudal single, frayed; ventral tuft 5-branched, frayed. Anal gills very long and pointed at apex (Fig. 15).

Tripteroides vanleenweni is a species near *T. bisquamata* as suggested by LEE (1946) and certainly not related to *T. atripes* as was erroneously stated by EDWARDS (1927) in the original description. *T. vanleenweni* may be differentiated from *bisquamata* in the males by the relatively shorter palpi, more numerous spiracular bristles, presence of prescutellars and relatively broader lobes of the ninth tergites; in the females by the presence of prescutellars, and usually more numerous spiraculars, while palpi tend to be slightly shorter and proboscis slightly longer. The single tarsal claw does not seem to be a reliable character (in fact the females are rather difficult to discriminate); in the larvae by the distinctly larger maxillary teeth, more numerous comb teeth, less numerous pecten spines with a different arrangement and the relatively short saddle hair.

Another related species, *T. plumigera*, collected in the Central Highlands, 3600

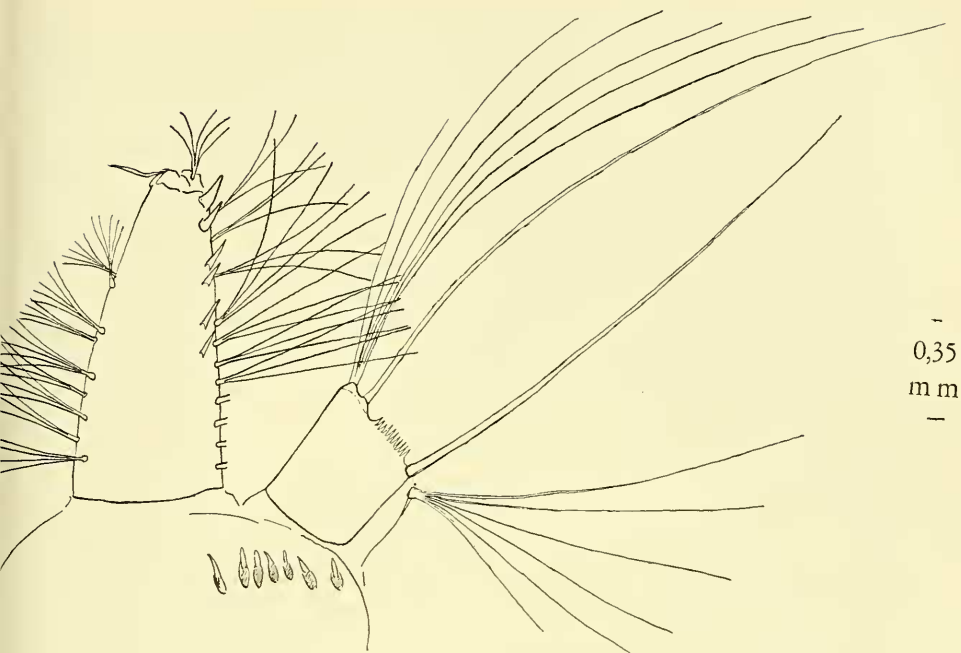


Fig. 15. Larval terminal segments of *T. vanleeuweni*

feet, was described by BONNE-WEPSTER (1948) — from females only. This species is probably distinct, though the differential characters mentioned by BONNE-WEPSTER (1946, p. 311) fall within the variation as noted in *vanleeuweni*.

Tripteroides kingi Lee

LEE, D. J., 1946, Proc. Linn. Soc. N.S.W., vol. 70, p. 256.

Type locality: Mt. Dafonsoero, Cyclop Mnts., 3000 ft.

LEE (1946) based the definition of this species on one male and three female specimens, all collected at about 3000 feet.

Specimens bred by the author from *Nepenthes* pitchers in grass land, foothills of Cyclop Mountains, about 1000 feet, do not entirely agree with LEE's description. One should allow, however, for a greater variability in the material than stated by LEE, so it was considered to include the Ifar specimens in *kingi* and to extend the description, rather than describe still another species. The Ifar series comprises 40 male and 36 female specimens, with connected larval skins.

Larvae of *T. kingi* were exclusively found in *Nepenthes* pitchers; they were found associated with *Tripteroides* (R.) *filipes* and *T.* (R.) *bisquamata*.

Obvious differences in relative numbers of larvae of these species were noticed in the Ifar grass lands. In pitchers growing on the open grassy slopes *bisquamata* was the dominant species by far, *kingi* was only found occasionally. Pitchers growing in the grass lands near the border of rain forest harboured *kingi* as the

dominant species, *bisquamata* being a good second. *T. filipes* was present in either locality in about the same rate.

Male. Clypeus black, there may be a few white scales present on its dorsal surface but this is probably not a constant character. Palpi and proboscis black-scaled, the former 0.20—0.25 the length of the latter. The proboscis never was found to be distinctly longer than the fore femur but about as long or slightly shorter. Pleural integument of thorax very dark; the posterior pronotum is distinctly dark scaled in the upper part; sometimes a weak posterior pronotal bristle present; 4—6 spiracular bristles; 2—3 pairs of prescutellars. The hind femur is paler, white scales are present towards the apex. The upper fork cell of the wings is twice the length of its stem at most. The borderline between white and dark scaling on the abdomen is distinctly serrate on all segments. The lobes of the ninth tergites of the terminalia are distinctly more rounded and relatively longer than illustrated by LEE; 6, 7 or 8 setae on top (fig. 4).

Female. Like male in most respects. Palpi in the Ifar specimens are longer than stated by LEE; 0.2 the length of proboscis. Proboscis as long as fore femur.

Larva. Clypeal spines short and blunt. Antennal shaft hair long, single or bifurcate, at $1/4$ away from the apex. Head hair A single, long; B bifid, near anterior border of head capsule; C single, behind level of A; d bifid. Maxilla with main tooth about $3/4$ the length of maxilla body, at least 5 smaller assessorary teeth of decreasing size present (fig. 11). Comb on 8th abdominal segment comprises one single, large and pointed tooth. Siphonal index 1.8—1.5, siphon only slightly tapered towards apex, slightly bulging at the dorsal side. Four to five pairs of pecten spines present, decreasing in size and bluntness from apex towards base, no spines present in basal $1/3$. Apico-dorsal spine long and slender. Ventral siphonal valve hair relatively short, bifurcate. 5—7, two-branched, frayed, dorsal hairs; 8 mostly two-branched, frayed, ventral hairs, basal one three-branched. Saddle with small spines at distal margin; saddle hair 2- or 3-branched, long and frayed. Dorsal subcaudal 2-branched, long, frayed; ventral subcaudal single, frayed. Ventral tuft 3- to 6-branched, frayed. Anal gills about as long as siphon, narrow, pointed at apex.

Tripteroides cuttsi spec. nov.

Type specimen male Hj. 13-a with connected larval skin.

The source of the type series of males, females and connected larvae is Homejo, Kemabu Valley, at 6000 ft, collected from climbing *Nepenthes* in moss forest, VIII.1958. Other specimens were collected at Enarotali, Wissel Lakes, from *Nepenthes* in similar localities, also at about 6000 feet. Females, most probably belonging to this species though some have the pleural integument less dark coloured than those bred from larvae, were annoying biters in daytime in the forest at this altitude. They were caught in flight together with females of *Tripteroides* (M.) *microlepis*. The larvae were found associated with *T.* (R.) *flabelligera* and *T.* (*Mimeteomyia*) *microlepis*.

Male. Head dark scaled, few pale scales on the nape, laterally down the head pale areas, dark erect scales behind, a narrow pale rim of scales to the eyes. Clypeus black with several small white scales. Proboscis black scaled, palpi 0.2 the length

of proboscis, proboscis as long as or slightly shorter than fore femur. Integument of thorax blackish. Scales on mesonotum dark brown, spindle-shaped, some light scales present at the anterior border. Pronotal lobes white-scaled; posterior pronota white-scaled in the under part, upper part clothed with dark brown and black scales. No posterior pronotal bristle; 5 medium-brown spiraculars and 2 pairs of prescutellars present. Legs are dark scaled, femora with light scales on ventral side from base to well beyond middle; hind tibia 0.8 the length of the mid one. Wing scales as in the *vanleenuweni* group; upper fork cell twice the length of its stem, fork cell bases level; wing length 3.8—4 mm. Abdomen with dorsum black scaled; venter white-scaled; large white-scaled, more or less triangular patches laterally on the tergites giving a serrate border line between light and dark scaling. Lobes of 9th tergites rather narrow and widely separated; in distal part with 9—10, rather irregularly arranged setae which are long, gradually tapered in the apical part and all of them of about the same size (Fig. 5).

Female mainly similar to male. Palpi about 0.2 the length of proboscis, extending beyond clypeus for twice its length. Proboscis 0.8 the length of fore femur; fore femur relatively longer than in male. Wing length 4—4.5 mm.

Larva. Clypeal spines are very short and blunt. Head hairs delicate, A single; B trifid, near the anterior border of head capsule; C with two branches, behind the level of A; d 2—4-branched. Maxilla with a large tooth, as long as the maxilla's body and four to five accessory teeth, as illustrated in fig. 12. In some individuals the angle enclosed between apex and base of the large tooth is almost 90°, in others however it is appreciably less. Antennal shaft hair 3-branched, far beyond middle. Stellate hairs with 2 to 7 branches (usually 4 to 5). Comb on 8th abdominal segment comprises only one large tooth, two teeth of equal size are present in one specimen. Siphon rather short, cone-shaped, index 1.5. Pecten of 4 strong teeth arranged from $1/4$ basally towards apex; 8 dorsal hairs present which are bifid; 6 ventral hairs, bifid as well except for the trifid basal one; ventral siphonal valve hair long and trifid. Saddle hair with two long and plumose branches; saddle with many delicate spines along its distal margin; dorsal subcaudal two-branched; ventral subcaudal single, both plumose and long; ventral beard with three plumose branches. Anal gills as long as siphon, rather blunt at apex (Fig. 16).

I take pleasure in naming this species after the Reverend W. CUTTS, a missionary working for already many years at Homejo among the Moni tribe and whose hospitality I enjoyed during a stay at his station.

Tripteroides cuttsi comes near *T. kingi* as defined by LEE (1946); the main differences are to be found in relative size of proboscis, palpi, fore femur and fork cells of the wings. The male terminalia are very distinctly different. Larval differences are found in the large apical maxilla tooth and in characters concerning numbers and arrangement of hairs and spines on siphon and anal segment. *Tripteroides cuttsi* is a common species at Enarotali, where many adults were bred from larvae. A peculiarity was that larvae flown to the laboratory at Ifar managed to pupate but all died subsequently in the pupal phase (whereas *T. flabelligera* and *T. microlepis* developed and hatched as normal at Ifar, where afternoon temperatures may be 10° C. higher than in the forest near Enarotali).

Tripteroides adentata spec. nov.

Type specimen male If KK-a with connected larval skin.

The collecting locality of the type series is Cyclop Mountains near Ifar, collected from climbing *Nepenthes* in virgin rain forest at 1500 feet, IX.1958. There were no other species found associated with the larvae.

Male. Head with flat, reflecting dark scales on the nape, a small patch of lighter scales more caudally reaching to vertex, erect dark scales at the caudal border, a narrow rim of light scales borders the eyes, white scales present laterally down the head. Proboscis and palpi dark scaled, the latter $1/2-5/4$ the length of the former; proboscis 78—80% the length of fore femur. Clypeus dark, bare. Antennae plumose, torus black, clad with many small whitish scales. Scutal integument blackish brown, mesonotal scales spindle-shaped, dark brown-bronzy, few lighter scales present on anterior border; 2—3 pairs of prescutellar bristles. Pleural integument dark brown, a shade lighter in caudal part. Pronotal lobes with dark bristles, white scales in lateral, darker scales in medial part; posterior pronotum largely white-scaled, upper part very distinctly dark-scaled; 2 small pale posterior pronotal bristles present; 8—9 dark spiracular bristles. Pleura largely covered with purely white scales. Legs dark scaled, light scales present on coxae and on ventral surface of femora, most in hind legs; hind tibia 0.8 the length of mid tibia. Wing scaling as in the *vanleeuweni* group; upper fork cell about twice the length of its stem, fork cell bases level. Wing length 4.0—4.5 mm. Dorsum of abdomen dark scaled, white scales present laterally on tergites, venter white scaled, border line serrate from 2nd segment onwards. Lobes of 9th tergites relatively long, well-separated, 7—8 stout setae on top as illustrated in fig. 6.

Female mainly similar to male. Palpi about 0.25—0.3 the length of proboscis, extending beyond clypeus for three times its length. Proboscis 85% the length of fore femur. Wing length 4—5 mm. Last tarsal segment of hind legs with 1—2 claws, in one specimen different on either side (not mounted).

Larva. Clypeal spines short and blunt. Antennal shaft hair single or bifid, beyond middle. Head hair A single, rather long; hair B with two branches, near anterior border of head capsule; hair C 2 to 3-branched, behind the level of A; d with 3 branches, relatively long. Maxilla with apical teeth, the longest one is slightly shorter than the body of the maxilla, 4 or more accessory teeth present as illustrated in fig. 13. Stellate tufts on thorax and abdomen 3—7, exceptionally up to 11-branched (most 4—5), very conspicuously frayed. Lateral comb on 8th segment is absent. Siphonal index 1.5 or slightly more, siphon distinctly tapered towards apex; pecten comprises 2×4 or 5 rather irregularly arranged spines, 2 conspicuously stout spines present at extreme apex, pecten spines are absent in basal part of siphon; apico-dorsal spines long and slender. Ventral siphonal valve hair long, with 5 branches. Dorsal hairs 10—12, single or bifid, occasionally up to 4-branched, distinctly frayed; ventral hairs 10—11, with 2—3 branches, frayed. Saddle with minute blunt spines covered all over, a row of sharp spines present at distal margin; saddle hair bifid. Dorsal subcaudal bi-trifid; ventral subcaudal single-bifid. Ventral tuft with 3—5 branches; all these hairs are inconspicuously frayed. Anal gills about as long as anal segment, pointed at apex. (Fig. 17).

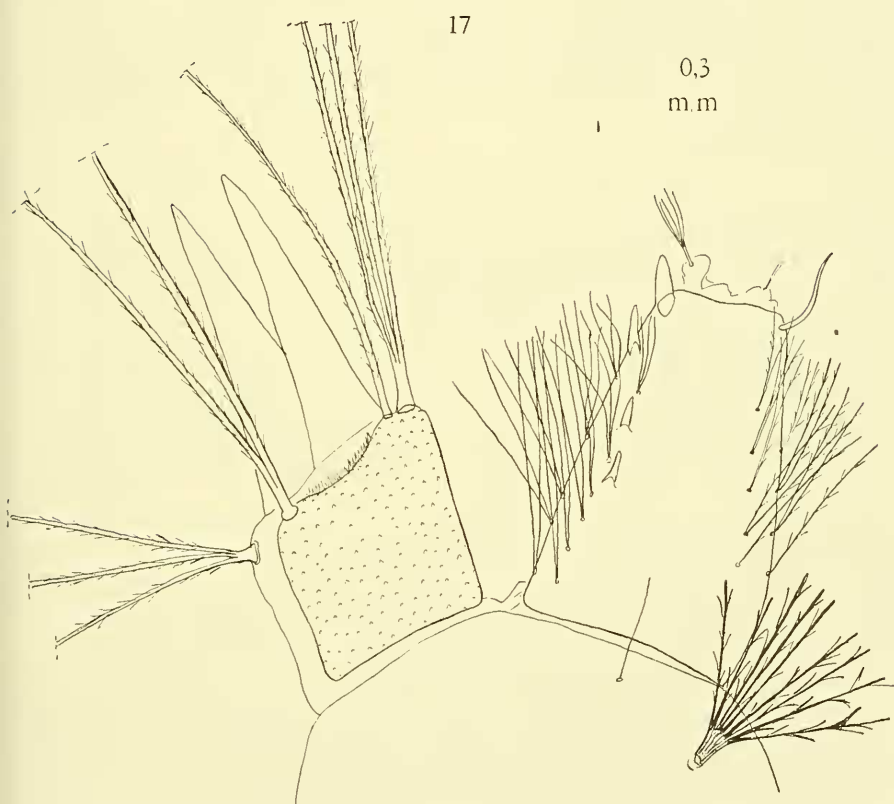
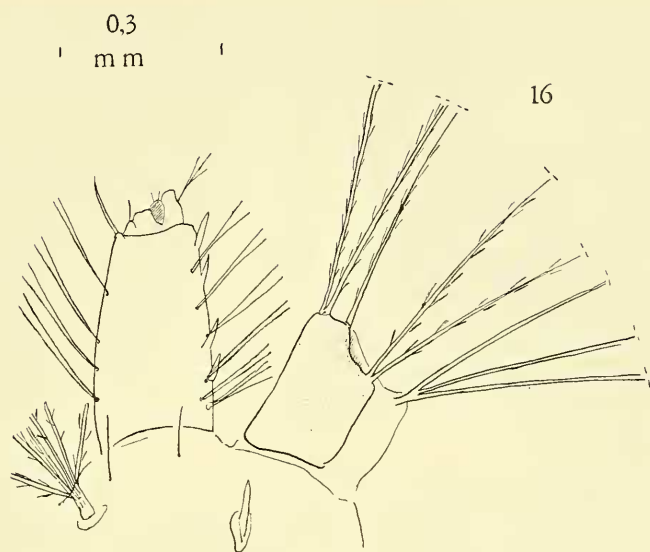


Fig. 16. Larval terminal segments of *Tripteroides cutsi*. Fig. 17. The same, of *T. adentata*

The species is characterized in the adults by relative dimensions of palpi, proboscis and fore femur, the high number of spiracular bristles and the presence of weak posterior pronotal bristles. In the larvae the absence of the lateral comb on the 8th segment is a most conspicuous character.

OBSERVATIONS ON THE BIOLOGY OF *Tripteroides bisquamata*

Pitcher plants in the grass lands at Ifar have been identified as *Nepenthes mirabilis*, it is a species with hooded pitchers. Young pitchers, which are completely closed, contain a clear, colourless and rather viscous liquid with an acid reaction (pH according to the Lovibond Universal Indicator < 4). Once the pitcher has opened the liquid becomes coloured to a yellowish shade (still before any insect has drowned) and it gradually becomes less viscous. Since the pitcher seems to be shielded quite effectively this reaction is probably not due to dilution with rain water.

At Ifar, practically every green pitcher searched harboured larvae; the same was found in pitchers of a climbing *Nepenthes* in moss forest near Enarotali (Wissel Lakes district). A sample of about 100 pitchers from swampy grass land in a deforested area a few kilometres from the last locality however did not yield a single larva; maybe this area was not yet invaded by a *Tripteroides* species from the forest or the species present there lacked the requirements to deal with the ecological conditions of the open swampy grass land. (The same was found in *Colocasias* axils in the open country which did not yield a single *Tripteroides* or *Harpagomyia* larva).

Table I

| pitcher | number of days after opening; first control was positive | contents of pitcher |
|---------|--|---------------------|
| A | 2 | 33 1st inst. |
| B | 3 | 8 1st inst. |
| C | 2 | 10 1st inst. |
| D | 1 | 23 eggs |
| E | 2 | 4 1st inst. |
| F | 2 | { 1 1st inst. |
| G | 1 | { 2 eggs |
| H | 4 | 20 eggs |
| | | 40 1st inst. |
| X | 24 | 3 1st inst. |
| Y | 17 | 1 2nd inst. |

Full-grown still closed individual pitchers at Ifar were labelled in order to find out how long it is before eggs and larvae appear after opening. From table I it will be clear that a pitcher is invaded straight after it has opened, probably within 24 hours: the female mosquitoes manage to enter and leave again through the still narrow slit between the pitcher and its hood. The pitchers labelled X and Y were thoroughly rinsed with tap water straight after opening and sub-

sequently 20 cc of tap water given as a substitute. It took a much longer time before some eggs were laid inside these pitchers, giving some evidence that eggs are not deposited at random; a pitcher attractive to gravid *Tripteroides* has to provide special stimuli of some kind. These stimuli do not depend on the presence of drowned insects inside, as eggs were usually found in normal pitchers before any victim was caught. In fact newly opened pitchers are much more attractive than older ones. In the field eggs were only found in recently opened pitchers.

Out of 120 pitchers 72 contained larvae of the same age group, presumably originating from a single invasion. In 11 individually labelled pitchers 7 were invaded straight after opening and never received an additional batch, 3 received a second batch of eggs later on, 1 was invaded at four different times, all over a period of two months. The nature of the attracting stimuli is unknown, they obviously were selected by the mosquitoes as an advantageous device against overcrowding. To the human nose an old pitcher smells quite differently from a recently opened one.

It was impossible to induce *Tripteroides bisquamata* to lay eggs in anything beside pitchers; plastic vials of roughly the same size as a pitcher, containing 10 cc of liquid from still closed pitchers, from old ones or containing tap water and hanging between the pitcher leaves also obtained only negative results.

Tripteroides bisquamata eggs are relatively large, spherical bodies with one pole distinctly more pointed than the other; they are laid apart and may float on the surface or sink to the bottom, which does not seem to affect hatching. It takes the eggs about 24 hours to hatch.

There is a variation in the numbers of eggs laid per pitcher, but the high numbers found in some of them may have originated from more than one female. There is no distinct correlation between size or contents of pitcher and the number of eggs laid in it. An average of 15 cc of fluid is most commonly found, it may however be as high as 50 cc; the maximum found in one pitcher was 76 cc (containing only one larva). The maximum number of larvae found in one pitcher was 40 (1st instar), a number well under the figures of BAISAS (l.c.) who collected up to 173 larvae from one pitcher in *Tripteroides* (*Tripteroides*) species.

The method of using individually labelled pitchers allowed for an estimation of the duration of larval life under natural conditions; it was found to take on the average 30 days from egg to pupa. The first pupa in individual batches appeared in 24—33 days.

There is an appreciable variation in duration of the several instars, especially in the fourth. The figures as observed under natural conditions are presented in table II. In the laboratory the 4th instar with subsequent pupating may be prolonged under unfavorable conditions as long as 50 days.

A point of considerable interest is the relation between the number of larvae present initially (as young 1st instar) in relation to the number reaching pupal stage, derived from them. As already pointed out in the introduction, the amount of available food seems limited, the number of eggs laid in one pitcher during the first day or first couple of days after it has opened, never can be in relation to the amount of food present a couple of weeks later, unless there is an average sufficient quantity always present per pitcher and the size of an egg-batch laid per mosquito per pitcher has been adapted to it in the course of evolution so as

Table II

| instar | min. observed duration in days | max. observed duration in days |
|-----------|-----------------------------------|-----------------------------------|
| egg | \pm 24 hours | |
| 1st inst. | 3 | 6 |
| 2nd inst. | 4 | 8 |
| 3rd inst. | 6 | 10 |
| 4th inst. | 8 | 36 |
| pupa | 4 | 7 |

to take the optimum advantage. Such a mechanism however seems highly improbable here. It implies an individual pitcher receiving one single batch of eggs at the time of opening, only possible when a mechanism was in existence allowing the gravid female to recognize and avoid a pitcher visited already before. As a result one should find some regularity in the number of eggs per pitcher. It seems more likely in the present case that the females are able to recognize young pitchers from old ones, a factor contributing to the limitation of the number — and the waste — of eggs per pitcher. The other limiting device in operation is cannibalism among the larvae which can be related to the amount of available food at any time. This method produces a waste of larvae several times but on the other hand allows a high output where more than the average amount of food becomes available.

In 13 labelled pitchers the course of development was checked regularly, allowing for a fairly reliable census of the mortality under natural conditions. A record of the course of development in these 13 labelled pitchers is given in table III. The figures from 10 labelled pitchers which could be followed from the beginning to the end are presented in table IV. An average mortality as high as 50% was observed before the 4th instar was reached. Only 26% of those present initially eventually pupated. Pupae were removed from the pitchers so there is no figure for their natural mortality; it will be comparatively low. A pupa suffering from predation by larvae was never observed.

The raising of additional batches did not seem a success in the labelled pitchers. In four of them 17 1st-instars were traced (this number may have been higher as predation may have occurred before control); only one larva managed to pupate at the end.

In addition to the data from labelled pitchers, an analysis was made of the contents of 120 pitchers chosen at random in the field. The contents of these pitchers were emptied in a white, enamelled pan, the pitcher subsequently torn open and washed carefully in clean water and all thoroughly searched for larvae and pupae. It is probable that some 1st instars were overlooked still, as it is very difficult detecting them between the many insect fragments present. As a consequence the average number of young instars as given in table V may be somewhat higher in reality, yet I feel confident the error made is not too serious.

The data from these 120 pitchers are represented in table V, the figures have been arranged in four categories: (a) pitchers containing young instars only (1st or 2nd), presumably pitchers which have opened recently; (b) those containing

Table III

Individual records of the course of development in labelled pitchers.
Those marked + are used for calculation of the average figures of Tab. IV.

| sign pitcher | number 1st instar present initially | number of derived 4th instars | duration developm. in days 1st → 4th | number reaching pupal inst. | duration development 1st → pupa in days |
|--------------|-------------------------------------|-------------------------------|--------------------------------------|----------------------------------|---|
| A+ | 33 | 11 | 17—24 | 10 | 27—43 |
| B+ | 8 | 3 | 13—17 | 2 | 24—32 |
| C+ | 10 | 7 | 17—24 | 4 | 33—39 |
| D | 23 | accident | | | |
| E+ | 4 | 4 | ? | 4 | 31 |
| F+ | 3 | 1 | 20 | — | — |
| G+ | 20 | 14 | ≡ 17 | 7 | 30—40 |
| H+ | 40 | 20 | ≡ 19 | 9 days later 16 left accident | |
| I + | 4 | — | — | — | — |
| K | — | 13 | — | 7 | 15—36 |
| L | — | 16 | — | 9 | 21—33 |
| | | | | | } 4th ↓ p |
| Y+ | 3 | 1 | 14 | 1 | 29 |
| X+ | 2 (2nd) | 2 | 8—15 | 2 | 16—34 |

Table IV

| Number of pitchers | number 1st inst. present initially | aver. numb./p. | number reaching 4th inst. | aver. numb./p. | number larvae pupating 30 | aver. numb./p. |
|--------------------|------------------------------------|----------------|---------------------------|----------------|---------------------------|----------------|
| 10 | 127 | 12.7 | 63 | 6.3 | 30 (in 9) | 3.3 |

all larval instars, presumably pitchers which were invaded more than once; (c) those containing old instars only (3rd or 4th); (d) containing pupae.

Only three pitchers contained pupae only, in 27 one or more larvae were present as well; these larvae are accounted for in category (b) or (c), the pupae in (d). It is assumed that the average number of larvae present initially is the average

Table V

| | number pitchers investigated | total number larvae | aver. number larvae/pitch. | aver. cc /pitch. |
|-----------------------------|------------------------------|---------------------|----------------------------|------------------|
| 1st and/or 2nd | 23 | 249 | 10.8 | 15 |
| 1st a/o 2nd and 3rd a/o 4th | 48 | 390 | 8.1 | 15 |
| 3rd and/or 4th | 46 | 251 | 5.4 | 13 |
| pupae | 30 | 70 | 2.3 | 12 |